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Commanding the Computer:

Functions and Concepts of Videotex Technology for Eighth-Grade Students

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ABSTRACT

This study combines quantitative and ethnographic methods to analyze middle-school students' uses and understandings of microcomputers and videotex. As a singular experiment in teaching library research skills, 27 eighth graders were assigned to search an online encyclopedia in preparation for writing a science theme. The students' operational practices and associated conceptual understandings were interpreted as a multimodal case study of videotex use. Analysis of data from hard copies of the students' disk records (an unobtrusive measure), participant observation during naturalistic computer use and a direct, hands-on test of computer competence at the project's end, supported five tentative conclusions: the students typically (1) mastered only the simplest videotex commands without improving their rate of error over time, (2) had difficulty understanding the concepts and vocabulary but not the structure of electronic menus, (3) accessed only a small quantity of electronic text compared to available printed materials, (4) exhibited the ability to search by keyword but found the videotex service inadequately cross-referenced, (5) required constant adult assistance to log on to the videotex service, to learn command operations and to store text on disk files. The study indicated that, as of 1984, commercial electronic text services lacked internal motivations to achieve operational efficiency and were unsuited to the educational objective of learning the cognitive skills of information processing.

Commanding the Computer:
Functions and Concepts of Videotex Technology
for Eighth-Grade Students

Electronic data bases have emerged as an effective information source in libraries and offices and are being tried in schools to teach the cognitive skills of information processing. Teachers in all areas and at all levels are becoming increasingly computer literate (Kull & Archambault, 1984; Anderson, 1983), but practical applications of computers outside programming and drill are scarce (Becker, 1983; Beveridorf, 1985; Williams & Williams, 1984). Commercial videotex, a recently-developed online technology for the general nonexpert consumer, combines microcomputers with distant electronic data bases by means of communications software to form an interactive information system. Electronic publishers are adapting this technology to the educational market's needs (Cook, 1984), and classroom teachers and librarians are investigating this option (Craver & Ounanian, 1984; Howe, 1983; Martin, 1984). Searching an electronic data base could provide extended experiences with hierarchical search ("treeing"), association ("branching"), concept generalization and narrowing and so on, language arts skills commonly taught using only print resources (Eastman, 1984(a). To date, however, no systematic study of videotex in middle or secondary school has been conducted. Using videotex to research large data bases has instructional appeal because (1) it applies computers to a wide range of subject areas while teaching basic language arts skills and (2) computers appear to generate motivation to achieve among some--perhaps most--students

(Paisley & Chen, 1982; Williams & Williams, 1984).

But the interfaces between the experts who design computer-based systems and the non-expert users of those systems generate widespread technological irritation (Chalgren, 1983; Eason, 1976). The expert's operational understandings are rarely available to the nonexpert, resulting in operating rules that users find inconsistent and illogical. Moreover, the communication problems compound when adults design systems for children because there is little information on children's use and understanding of new technologies (Paisley & Chen, 1982).

At the start of 1983, there were more than a 100,000 microcomputers in American public schools, with more than two-thirds of them located in middle and junior high schools (Becker, 1983); by 1986, the number was expected to be over a million in schools (excluding colleges). This technology holds the potential for teaching the information processing skills recognized as a fundamental part of middle-school curricula, but an examination of children's functional application and conceptual understanding is needed to determine how well the present videotex technology serves that educational purpose. LeCompte & Goetz (1984) have cogently expressed the need for such process-oriented research, but the only published reports of on-line projects are either at the college level (Martin, 1984) or involve data base search by librarians, not students (Craver & Ounanian, 1984; Manburg & Goldman, 1983; Sandy & Evans, 1981). Virtually all reports of computer projects at the elementary and middle levels concern programming in Logo or Basic, arithmetic software or word processing (Beversdorf, 1985; William & Williams, 1984).

This study focused on the operational skills and conceptual understandings of videotex likely to be developed in a school setting. The high

cost of videotex and associated equipment continues to make simultaneous use of videotex impractical on a very large scale (Cook, 1984; Eastman, 1984a), but small-scale shared installations might be practical at many middle and high schools. This project provided an unique case study of a realistic amount of videotex use in a field setting. It draws on unobtrusive quantitative measures, ethnographic research strategies and direct testing, providing a multimodal assessment of the project's process and results.

Method

This study focused on a science class of 27 eighth graders who used an interactive electronic encyclopedia to search for information on individual science topics (selected by the students). A grant from the Lilly Endowment funded the installation of nine computers and autodial modems, each attached to a dedicated telephone line, in nine adjacent carrels in a middle school's media center. The equipment configuration permitted one-third of the class at a time to independently search the electronic form of Academic American Encyclopedia. The curricular unit--including classroom preparation, electronic search and paper writing--lasted one month. According to the science teacher, and validated by a panel of other science teachers, this was a realistic amount to extract from the usual eighth-grade science curriculum. One week was spent in preparatory activities (selecting a topic, preparing lists of associated terms and concepts, introducing an electronic text workbook). Two weeks were spent in the school's media center while nine students at the time used the computers to search the electronic encyclopedia. In the final week, the students returned to their science classroom to complete and edit their papers.

Three sets of data were analyzed and interpreted for this paper: (1) The students' computer disks supplied a record of their commands to the videotex service and the text supplied in return; (2) the students' conversations and interactions during electronic text search provided observational feedback on their shared understandings of the technology's workings; (3) a hands-on test of computer competence assessed each student's mastery of videotex operations.

The study's subjects, 27 students in an eighth-grade science class, were selected because their class period fell in mid-morning (least likely to be interrupted by late buses, general school meetings and so on). The school district assigned students to this particular class in its normal way, without considering this project. The particular middle school was selected because it had several microcomputers already installed in its media center (library), facilitating the addition of more as a part of this project. (It was one of only three middle schools in the city.) The equipment utilized consisted of standard Radio Shack microcomputers, one of the three most common brands in public schools. The participating videotex service was CompuServe, one of the three widely available services in the United States and one of only two carrying an electronic encyclopedia (the same one) at that time. CompuServe was selected as the videotex service because it is a consumer service for the home, office and school, not requiring specialized training (in contrast to library services such as BRS and DIALOG). The communication equipment (autodial modems, phone lines) were standard commercial models and the normal method of interconnection (see Eastman, Daugherty & Agostino, 1983; see also Chalgren, 1983; Martin, 1984). The electronic encyclopedia searched was Academic American, the only one available in electronic form at that time and a standard middle-school reference tool carried by most middle and secondary schools.

Therefore, despite the project's single case nature, tentative tranference of these findings to similar school situations may be warranted (Guba, 1981; Anderson, 1983).

After the move to the school's media center for "research," the teacher assigned all 27 students to one of the nine computers using a rotating schedule giving each student four or more 30-minute sessions on a computer over a period of two weeks (ten school days). Students had further individual access to the computers and CompuServe if they wanted additional research time. This computer access, though small in total minutes, exceeds the typical amount of time available in most school settings. Most schools making a major commitment to computer-assisted instruction assign whole classes to one or, at the most, several computers for computer-assisted activities (other than typing and basic programming).

The research team observed in pairs in the science classroom, acquiring familiarity with the style of the teacher and the classroom rules while learning the names and normal behavior patterns of the individual students. In the media center, seven participant observers in sets of two or three served as resource people and took field notes in the computer and print materials areas during the two weeks of computer use, focusing on observable student interactions with the computers and books/periodicals and verbal interactions among students or between students and teachers relating to the assignment. The goal was to see how the students accommodated this new technology within normal educational activity. After the two weeks of information search, the students returned to the science laboratory to write and edit their themes. During this writing week, each student was individually interviewed to assess his/her mastery of the computer operational processes that had been taught in a hands-on test given

informally as a part of a personal interview.

The results reported here, therefore, combine (1) analyses of the records of students' actual operational commands, (2) two weeks of daily observation at the computers (supported by six additional weeks of observation before and after the students used the videotex service) and (3) individual computer competence tests at the close of the project. These three methods of data collection were used to provide multiple insights into the students' use and understandings of videotex (Jick, 1983; Fetterman, 1984; LeCompte & Goetz, 1984).

Hard Copy Records

The students used individual computer disks to store what they accumulated in their computers' memories that later provided a hard copy of what they found. Storing the information they accessed in the electronic encyclopedia involved opening the computer's temporary memory (buffer) as a part of the initial logging-on procedure and, at the end of each session, transferring its contents onto their disks under an appropriate file name. The teachers and participant observers aided the students in attempting this process, but about one-fourth of the time all information was lost--resulting in the absence of a hard copy record. Most of the loss, however, occurred during the student's first computer session. Once students saw others receiving a hard copy of the previous day's stored information, motivation to master the storage process increased. Overall, 78% of sessions resulted in a hard copy (98 printouts from 127 sessions on computers). Not counting first tries, the students achieved a success rate of 84%. At the end of each day, a

participating teacher printed two copies of every student's file, supplying one copy to the student on the next day and reserving one copy for analysis. The records showed not only what the students found in the electronic encyclopedia but how they went about finding it.

Hard copies of the 98 daily records were then content analyzed to determine the students' use of operational videotex commands and structural videotex processes. Intercoder reliability for the three trained coders exceeded 95%. From these records, these authors analyzed (1) the students' frequency of using a sample of commands such as ENTER, M, S, T, HELP, SE and GO, a measure of operational skill and system appropriateness to student needs; (2) the students' frequency of selecting from videotex menus (lists of options), a measure of conceptual understanding of the hierarchical selection process; (3) the types of errors the students made, another measure of their grasp of the electronic search process; (4) the average number of electronic pages accessed, a measure of the quantity of information located; and (5) the students' rate of success in using search terms (locating specific articles by keyword), a measure of the responsiveness of the data base to these students' needs. Frequencies were tabulated by day to reveal patterns over time, by first and last session to measure the amount of individual change during the project, and for all students to count all commands used.

Observations

The observational portion of the data collection utilized a focused inquiry design emerging from systematic analysis of field observations which showed a great deal of student activity devoted to technical problems. The

ethnographic paradigm assumes equal validity for the constructed realities of the students, observers, teachers and system designers, but to avoid analyzing the observer's (or teachers') understandings of what was happening in this paper, we describe shared understandings based on conversational exchanges or computer interactions noted by at least two observers as patterns of student behavior (Anderson, 1985).

Observations recorded in field notes provided the raw evidence, later expanded in typed form. These were then coded and interpreted in related units using an inductive analysis method (Glaser, 1969). Altogether, 1092 observational units from 62 site visits were collected. This analysis draws on 255 units referring to operational procedures such as logging on/off, giving commands and task-related processes such as searching using keywords. Observational units referring primarily to print materials (occurring away from the computers), science laboratory activities (occurring before or after computer use) or general comments on the assignment or other activities were also examined for relevant technology-related meanings constructed by the students. The analysis, however, only reflects conversations and interactions during classtime.

Competence Tests

Immediately following the conclusion of the ten days of computer use, the participant observers administered 27 individualized interview schedules. To measure their operational competence, the students were asked to (1) log on to the computer, (2) open the computer's buffer memory, (3) use the express command GO AAE-110 to call up the electronic encyclopedia's opening menu and (4)

log off. (With the possible exception of opening the computer's buffer memory, these are common operations necessary to nearly all videotex users.) Test results were coded for success or failure at each of the four operations and whether assistance was sought from the interviewer or the student's workbook. Since none of the students brought prior experience with computers to this project, this test measured the students' mastery of the material explained in the workbooks and reviewed by the teacher during this instructional unit. (Because computer instruction and family computer purchases are proliferating, other intact school groups may contain mixes of experienced and inexperienced students.)

Results

Results from each of the three methods are reported separately. Each is accompanied by interpretive comments. The tentative conclusions reflect uses (functions) and conceptual understandings supported by evidence from two or more methods of data collection.

Analysis of Hard Copy Records

Analysis of the 3,087 operational commands attempted by the students on the 98 printouts shows repeated patterns in student approach and mastery of computer operations. Each student on average connected with the videotex service for 57 minutes out of the scheduled two hours of computer use. Over the period of four or five sessions, about one hour (half of the total time) was occupied in listening to the teacher, reading the workbook and learning to log

on. At the start, students had minor problems using the keyboard and associated conventions. They hunted for letters, confused zero and the letter O and had to learn to use shift and to hold one key down while striking another (for upper case and some operational commands). Some basic keyboard instruction would probably have been useful before beginning this project.

Altogether, the class generated 830 pages of hard copy, an average of 30 pages per student for the whole project. Per session, each student averaged 8.3 frames or about 460 words, much less than one page of a printed student encyclopedia.

Screen and express commands allowed the students to move within the electronic text. Analysis showed heavy use of the commands that appeared frequently on the students' screens. Commands such as ENTER (display the next page), M (go to the previous menu), S (scroll continuously to the end of the article), T (go the top videotex menu) and HELP (display assistance) were used 1830 times, accounting for 59% of the 3,082 total commands given.

Of these, ENTER, the simplest operation, was immediately learned and used 1435 times, accounting for 47% of all commands. Also, 24 students used M a total of 236 times, an average of 10 times each, showing student dependence on these two basic commands. Seventeen students used the S command 110 times, with five students accounting for 70% of the use. Most students who tried S once or twice apparently did not find this operation useful. Only eight students tried the T command, five only once. The students reported being confused by T because it threw them too far from their previous location. The HELP command was used by 15 students 35 times. HELP was perceived as something to avoid because it gave instructions for re-entering the system but no aid in correcting common errors (typically the reason for seeking help). Analysis showed no

relationship between the use of HELP and other measures of success or failure in using videotex.

Two express commands, SE and GO, were explained in the students' workbook and by the teacher. These commands allowed the students to bypass menus and proceed directly to specific articles or text. Typing SE, for example, creates the opportunity to enter a search term at any point (within the electronic encyclopedia) and was used by 17 students 98 times. Two students, however, made nearly half the uses, suggesting that many students did not find this bypass procedure especially useful. The GO command served to jump directly to a particular menu or page within the electronic text. GO was used 66 times by 17 students, but only 11 students used it to go to a specific electronic page, the more efficient usage (although a few students accessed such short articles they may seem little need to return to specific pages in subsequent computer sessions). More typically, students tried the GO command but made errors in following the format (GO AAE-xxx) and rejected it as too difficult. Examination of individual student records showed that five of the 27 students made frequent use of the express commands, and the rest dropped them after one or more tries. This small amount of usage of both express commands suggests that most students who tried them found express commands impractical or not useful.

Half of the words entered by students to locate articles in the electronic encyclopedia (search terms) were successful. Altogether they entered 307 search terms, rising from 67 on the first day to 93 on the last day of videotex use. However, the rate of success dropped from 57% on the first day to 46% on the last day. Observation showed that in the last two sessions, students typically drew their search terms from previous days' printouts of electronic

encyclopedia articles. These terms proved largely unsuccessful.

Over the ten days of the project, the students made four types of major errors. Two of these, using plural search terms (7%) and misspellings (20%) were common student typing/writing errors. Two other problems appeared to reflect a lack of understanding of videotex operations. Twenty-one percent of errors consisted of entering a search term at a prompt (without entering a prior command). In the remaining 52%, the students typically failed to enter an appropriate command. This suggests that many did not read the screen to learn what they might do and did not have a reportoire of express commands. The total amount of error (161) was relatively low overall (5% of the total commands given), and the rate of error remained constant over the ten days of the project, failing to reveal an anticipated decrease with computer experience. This suggests that increased experience with screen directions and the workbook did not increase the students' mastery of videotex operations.

This project assumed that using videotex could teach traditional information processing skills such as hierarchical sequencing through subordinate/superordinate categories and associating ("treeing" and "branching"). Both skills are fundamental to thinking and writing processes such as classifying, narrowing, ordering, progressive abstracting, progressing logically and encoding. This study tested this assumption by examining students' use of menus and submenus within the electronic text on their first and last days of computer use. Records showed that these students were presented with 80 menus and made 53 selections from them on their first day of computer use (N=15, the rest failing to successfully store any text). On the last day, 312 menus were presented and 209 items selected (N=26). The rate of selection remained constant, then, at two-thirds (67%) over the ten days of the project although

the number of menus accessed per day increased by about four times. This suggests that these students were initially familiar with menus but gained in their ability to access greater amounts of electronic text.

Of the total number of menus presented and of the total number selected, half were videotex system menus (presenting system choices between home or business, magazines or education and so on, or standardized options such as: 1. Help; 2. Enter a new search term). The other half were topic related, listing either an array of article titles or subtopics within an article. Since the students accessed as many videotex system menus (and selected from them) as topic related menus, this means they spent half their decision time on videotex operations and half on their research topic. It suggests that videotex takes as many branching steps to access useful reference material as to pursue distinctions within a topic.

Conversations During Computer Use

Observations showed that the students brought an understanding of menus from previous learning experiences. Their questions on initially seeing an electronic menu related to the process of selecting by number, not the meaning of the presentation: "What do I do after 3? Push ENTER?" "Which one do I pick here?" However, the vocabulary level of many menus exceeded the abilities of students reading at or below grade level as these exchanges reveal:

S: Okay [submenu appears on screen].
Obs: What is this [pointing to an item]?
S: Instinct [blur] and birds.
[Student calls up "extinct and endangered birds"]
Obs: Why are you picking this?
S: I got the others before. I'm trying to get all of them.

And:

S: [pointing to screen item ANATOMY] What is it?
Obs: It's parts of the body and how the horse uses them.
S: Oh. I don't have that one yet.

As these conversations also indicate, the students methodically went back to a menu and picked off each category one by one, putting each into their buffer memories. They commonly defined the project as storing information in their buffer memories in order to get a long printout to read later, not as an activity requiring selective reading of the screen's content:

S: Are you writing down all the stuff that's going by here [on the screen]?
Obs: No. Are you reading it?
S: We ain't supposed to yet, are we?
Obs: [shrug] I don't know.
[Student turns away and faces screen, paying more attention to it.]

Students used the screen content as a marker, identifying their place in the process in comparison to the screens illustrated in their workbooks. The rules they informally learned were to "memorize what you are supposed to do during log-on because it makes no sense" and "just push ENTER after everything." The students typically talked to themselves (or the computer) during the early learning process:

S: [enters command] Nothing happened. If I'd read [the screen], I'd find out. [presses ENTER as directed on the screen] Okay.

Student conversations showed rapid understanding of the concept of an "article" within the electronic encyclopedia and the process of moving through menu items to obtain all the text. Eventually, many students discovered that

the ENTER button could be pushed without waiting for each screen to fill:

S: Oh, that's neat! You could press buttons while it's reading, and when it gets to the end, it does it!

Here the screen functioned as a timer, telling the student when to act. As they gained control of the simple operations (screen commands), students saw themselves as then free to comment on a neighbor's procedures or otherwise occupy their time. The videotex service itself contained no apparent rewards motivating the students to increase their operational efficiency in this school context. It was sufficient to be able to store a lot of text in the computer's memory. Task-oriented students focused on getting a particular search term to work:

S: [leaning to neighbor] You have it wrong.
OS: It's snow leopard.
S: It'll think it's a different kind of cat...snowleopard!
OS: That's what I want!
S: Yeah, see!!!

For many students, achieving a long printout was the key to getting more relevant information from the videotex service. Students marked up their hard copies, turning to them as a resource for locating still more information:

Oba: What're you going to do today?
S: I'm going to try to get more information. Some of these words have more and some don't. Like radiation had a lot more--see... [shows me her printout with terms circled and marked].

For students with topics such as cancer and leukemia, this proved a fruitful process. For others researching cats, internal combustion engines or the moon, the articles provided few keywords. For example, words such as feline, Carnivore and Felidae appeared (in upper case) in the cat article and seemed

logical to the student but, inexplicably, did not function as keywords in the electronic encyclopedia (although upper case was supposed to indicate a keyword acceptable to the electronic encyclopedia).

Observation showed students attempting the SE and GO commands under the teacher's urging and abandoning them after a few tries. Repeated questions addressed to teachers and participant observers showed most students lacked an understanding of the express commands' utility. The following conversation shows a student learning operational commands while seeking information on the topic of white-tailed deer:

S: [to teacher] What do you do to get back, like to bibliography and stuff. Like this [holds up printout].
T: What page do you want to go to? You can just hit go.
S: Oh.
T: Do you want a new search term?
S: Yeah.
T: Okay [explains that the student should type SE at a prompt to get "Search term:"].
S: [Enters new search term] How do you do this? I don't want that "i" in there [refers to misspelled word].
T: You can just do this [uses backspacer and leaves].
S: I am stuck. [to observer] It keeps saying "no entries."
Obs: Try going to "types" at the bottom.
S: Where? [holds up printout to show that there is no entry for "types of deer" as on another student's menu]
Obs: Perhaps you can find something under "appearance." [Nothing relevant appears.]

This sequence occupied a substantial chunk of this student's time on the computer. Although he was introduced to at least two new operational commands, they had no practical result for him. Repeated frustrations of this sort led to audible reactions when students found what they had been looking for: [when a submenu comes up, pointing, touching screen] "There! I got what I wanted!" Other students complained when the encyclopedia did not serve their purposes: "I didn't get much information. Nothing I needed." It became a game of

outguessing the electronic encyclopedia's logic to find the place where a student's information was hidden, not an exercise in utilizing logical movement from general to specific categories or in using multiple references to a single topic.

On a visual level, the teachers and observers repeated expressed frustration with noise on the screens (garbage letters between characters) and with jumps in screen typeface and line width. They were also disturbed by disconnections cause by momentary interruptions in the long distance interconnection. Student reactions, however, were passive and uncritical, implying that these matters were accepted or beyond control. Complaints that the videotex service lacked color and graphics or other video options never surfaced. The following illustrates the students' typical, mild interest in screen typeface:

S: [to neighbor] Is my computer different?
OS: [gives puzzled shrug and turns to observer]
Obs: You have a model 4; hers is a 3.
S: I like this kind of writing better.
[no comment from other student who has turned back to her computer]
Obs: Why?
S: I don't know. I can read it better. Neater, I think.

Observations showed no push to increase operational skills, no interest in how the technology worked at the videotex service end, no criticism of using a computer for information search. The students accepted this application of the technology as appropriate for a science class in middle school, but they expected only to use the technology, not understand it. And gaining a level of operational command barely sufficient to fill their computers' memories generally satisfied them.

Computer Competency

To find out how much control of the operational processes the students had achieved, the observers tested them individually at the project's close. Because two or three teachers and observers had been present and assisting students during all computer time, the information stored on their disks could have resulted from adult aid rather than student skill. None of the students had prior experience on computers except for games. We wanted to assess the level of computer competence each student achieved with videotex operations and therefore asked them to log on, open their buffers (computer memories), use the GO command to enter the electronic encyclopedia and log off.

Half of the students (13) could successfully log on without assistance, and another 7 students could log on using their workbooks; the other 7 students required adult help. Even after an average of four computer sessions, six students did not know how to open their computers' buffer memories, but all were able to log off (with or without their workbooks). These figures indicate that a large amount of adult assistance with computer and disk storage operations was responsible for the high success rate in achieving printouts.

The students were also asked to use an express command to indicate the level of efficiency in videotex operations they achieved. Twelve students could use the GO command without assistance, 7 managed with help, but 8 could not complete the procedure even with interviewer aid and their workbooks. Hence, less than half the class had learned this express command by the end of the project, despite repeated explanations by teachers and directions in their take-home workbooks. This supports the conclusion that the videotex service does not contain inherent motivations to increase efficient operations.

Conclusions

Generalizing from a particular set students, one site and a short-term situation to other educational circumstances is always tenuous, but this case study's results suggest guidelines for other teachers and researchers investigating videotex. Five general conclusions emerged from this analyses that should be considered when planning in-school applications of videotex for electronic search.

First of all, supervising adults appeared necessary to assist students and ensure that their electronic information was stored eventually on the students's disks. These students lacked keyboard skills and did not read the screen for instructions. Half the students were unable to log on to the system without assistance--forstalling the start of any electronic search--even after four sessions using the videotex service. More frequent use of modems and videotex would probably eliminate the need for continuous adult aid, but long-distance telephone costs make the unsupervised use of modems and videotex unlikely in any school setting.

Second, the videotex system did not appear to stimulate the students to master more and more efficient operational control, at least in an initial computer experience. About half the students in this project used only the simplest on-screen commands while half explored other command operations but typically used them infrequently. Most students seemed satisfied with relatively inefficient mastery. Their constant rate of error suggests that the majority did not improve their command of the operations with time--although a few improved and experimented (leading to errors). Under other circumstances,

familiarity with computer programming and/or word processing might alter this short-term response.

Third, the students were able to adapt their prior experience with the cognitive skills of treeing and branching to this computer experience. Although many had difficulty with menu categories (concepts and vocabulary), both records and observations showed the students' competence in using menu structures right from the project's start. But one problem unrelated to the students' skills was that half of all menu commands did not involve the students' topics, suggesting that videotex's procedures occupied a disproportionate quantity of users' research time and effort.

Fourth, videotex, as presently operationalized, may not be cost effective for schools. Installation and telephone line charges would have high costs relative to school budgets, and the option of local storage of data bases is not yet available. In addition, these students accessed a very small quantity of electronic text when compared with the available printed information. Videotex's advantages (such as simultaneous multiple access and timeliness) do not appear to outweigh its high costs as presently configured.

Fifth, videotex, as encountered in Academic American Encyclopedia, failed to incorporate sufficient cross-referencing to encourage learning cognitive skills such as hierarchical sequencing through subordinate and superordinate categories and associating. Only half of the search terms tried by the students were successful despite their apparent logic to the students and observers. And those keywords drawn from the students' previous printouts of Academic American articles had a lower rate of success than those made up (or drawn from other sources), demonstrating a lack of thorough cross-referencing in the electronic encyclopedia. This finding suggests that videotex as a system

and Academic American as a data base are currently unsuited to educational objectives.

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